Using Case-Based Reasoning to Build Intelligent Systems

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1 The Basics of Case-Based Reasoning

In this talk, we first present the basics of case-based reasoning –CBR in the following– and then we show how the CBR technology can be used for building intelligent systems.

The goal of case-based reasoning is to associate a solution $\texttt{Sol}(\texttt{P})$ with a new or *target* problem P, by reusing the solution $\texttt{Sol}(\texttt{P}')$ of a memorized problem $\texttt{P}'$. A CBR system takes advantage of a *case base* including memorized problems –or *source* problems– with their solutions to solve a target problem.

A *case* is a pair $(\texttt{P}, \texttt{Sol}(\texttt{P}))$, where P denotes the problem statement and $\texttt{Sol}(\texttt{P})$ the solution of P. The *case base* is a finite set of cases of the form $(\texttt{P}_\texttt{k}, \texttt{Sol}(\texttt{P}_\texttt{k}))$. A target problem P is usually considered as a "new case", denoted by target, and a source problem in the case base is denoted by source.

The case-based reasoning cycle relies on three main operations:

- *Retrieval*: a problem source *similar* to the problem target is searched in the case base. The problems memorized in the case base are considered as reference cases used to solve target problems.
- *Adaptation*: given a case retrieved in the case base, say $(\texttt{source}, \texttt{Sol}(\texttt{source}))$, $\texttt{Sol}(\texttt{source})$ is adapted in order to be reused for solving the problem target.
- *Memorization*: the problem target and the (building) characteristics of the solution $\texttt{Sol}(\texttt{target})$ can be memorized as a new case to be reused in the future.

These three steps can be nested: for example, retrieval and adaptation are nested in the case-based system described in [13] ; the learning step can take place within the retrieval and the adaptation steps as well, in order to learn retrieval and adaptation knowledge.

The implementation of knowledge-based systems relying on case-based reasoning gives rise to *case-based reasoning systems*. Given a target problem P, a CBR system exploits a case base and follows the preceding three-step cycle to solve P. The problem P can be of many types, e.g. interpretation, diagnostic, configuration, planning, etc.

2 A Bibliographical Tour

The technology of CBR has been extensively studied in the past years. Important textbooks

on the subject are [18] [10] [21] [23], and [1] about industrial CBR systems.

Important researcher groups working on CBR are based in Europe, e.g. Dublin, Kaiserslautern and Lyon. The *European Conference on Case-Based Reasoning* is organized every year since 1993 [24] [9] [6], and this conference becomes the *International Conference on Case-Based Reasoning* every two years since 1995 [22] [11].

In France, people studying CBR are members of a working group of PRC I3 (PRC IA before 1998) : see [15] for details on the research groups, and see [17] for details on the PRC I3 group.

A number of students have defended theses on many different subjects: learning in the CBR cycle [3], temporal processes and prediction [20], diagnosis and induction [2], use of CBR in optimization [8], industrial supervision [16], similarity measures [19], neural networks in CBR [14], object-based knowledge representation formalisms for building CBR systems [7] (see [5] on a related problem), case-based planning [12], ...

For terminating this short note, let us mention the publication in September 1998 of a special number on CBR of the *Revue d'intelligence artificielle*, where are addressed topics such as problem solving, knowledge representation, planning, supervision and cognitive aspects of CBR [4].

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